Machine Learning to Drive

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WAYVE

Where are the self-driving cars?

"Self-driving cars are no longer a futuristic AI technology. They're here" Andrew Ng, May 2018

"Self-driving cars are here!" Waymo 2019

WAYMO

"We will have complete autonomy in approximately two years." Elon Musk 2015

"When will think it's safe, full self-driving? Probably toward the end of this year" Elon Musk 2018

"I think we will be feature complete — full self-driving — this year" Elon Musk 2019


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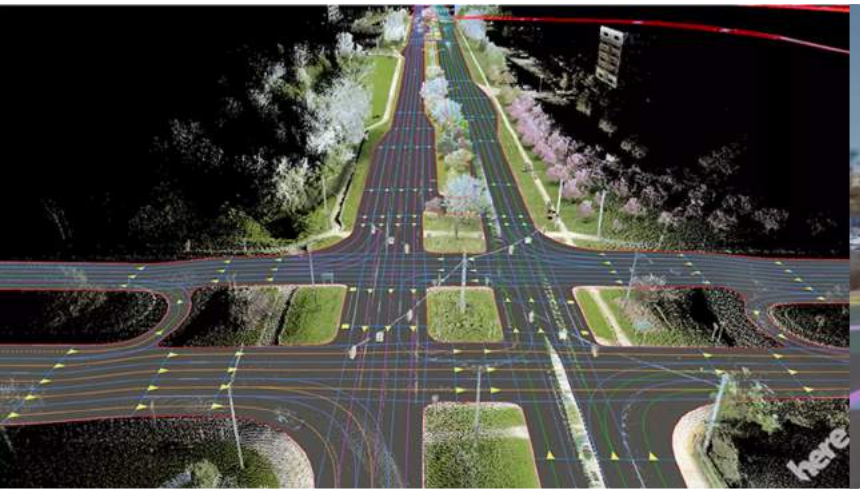


HD Maps

(brittle / slow to build / expensive to maintain)

LiDAR Sensors

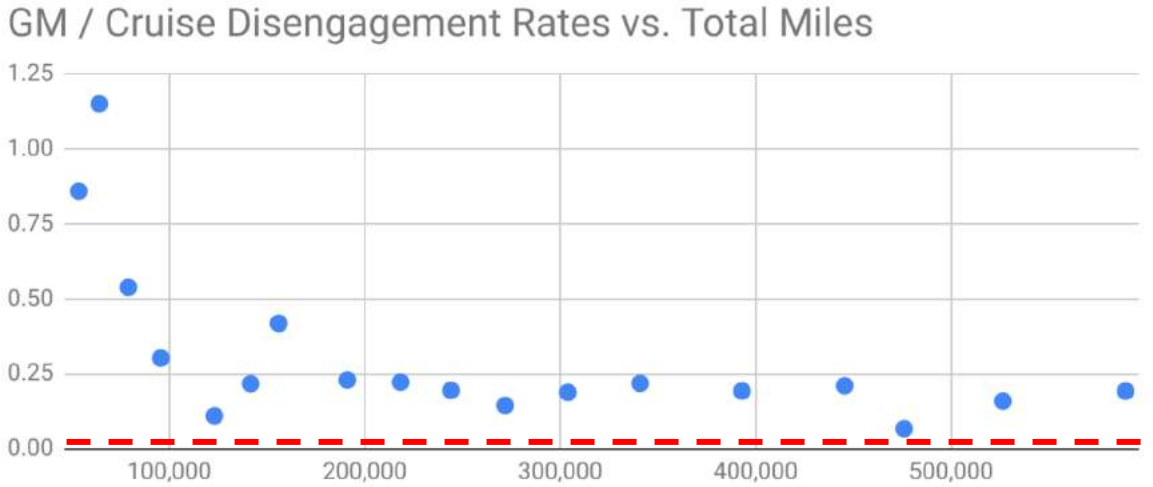
(expensive / short lifespan)

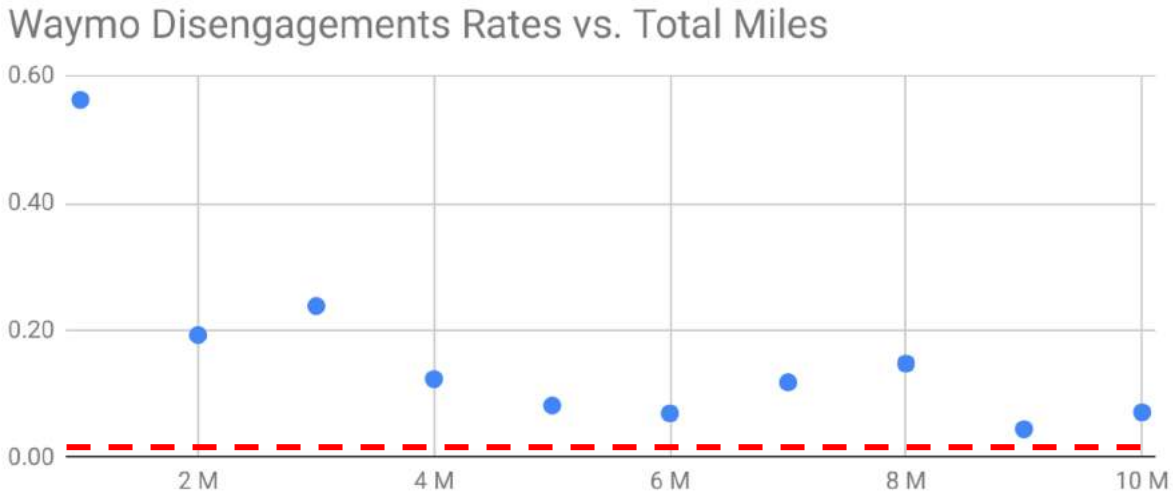
Hand-Designed Rules

(rigid / clunky)

Images borrowed from (1) The Drive, (2) Waymo 360° Experience: A Fully Self-Driving Journey and (3) Uber.

Performance is saturating no matter how many engineers and resources are thrown at the problem





Human Performance
(0.006 crashes per 1,000 miles)

California DMV Disengagement Reports 2014 - 2019

We have a different approach:

End-to-end deep learning

End-to-end deep learning is winning everywhere

2015 IMAGENET

2016 Baidu 百度

2017 AlphaGo

2018 SQuAD2.0 The Stanford Question Answering Dataset

2019 StarCraft II: Legacy of the Void, DOTA 2

Image recognition, text-to-speech, complex game agents, question + answering....

All are dominated by deep neural networks

Urban driving with end-to-end machine learning

Inputs: camera video and a sat-nav

End-to-end deep learning

Uncertainty propagation from *sensing* to *action*

Outputs: driving commands

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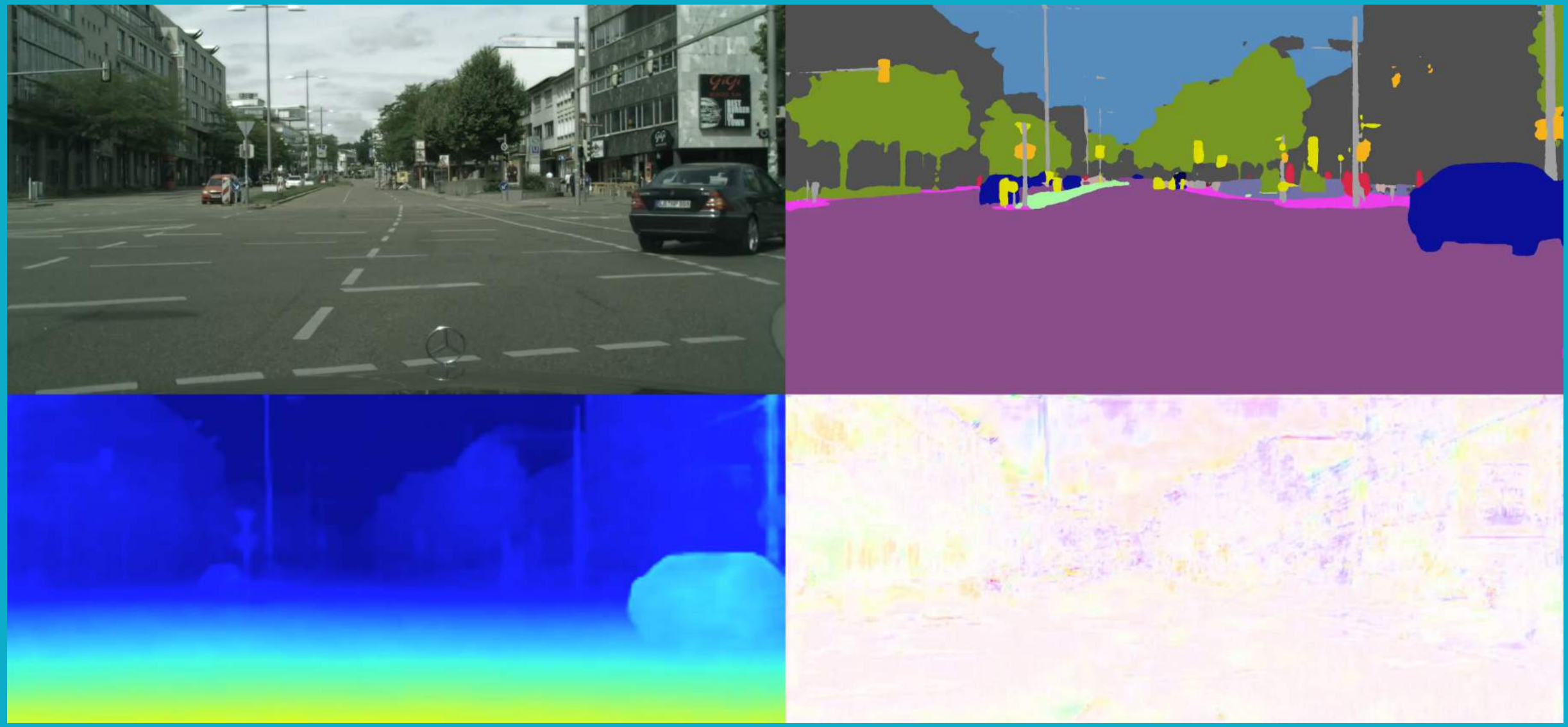
Wayve, https://wayve.ai/blog/driving-like-human, (2019)

SegNet, University of Cambridge, 2015



Multi-Task Scene Understanding, Wayve, 2018


B&B
Building Contractors
GB

	Constrained Setting	Big Data
Machine Learning	• Low engineering effort to create demo • Brittle representation • No performance guarantees	• Excels with increasing data and scale • Can learn powerful representations which generalise • Validate with statistical evidence
Human Design	• Possible to enumerate all scenarios • Analytical safety guarantees • Limited complexity	• Unachievable to identify all edge-cases • Too complex for safety guarantees • Requires extremely large engineering effort

A complete paradigm shift for AVs

- Low vehicle compute and sensor requirements
- Large training compute and data requirements
- Increased vehicle intelligence
- No reliance on HD-maps
- Ability to leverage simulation for training
- Lean and elite engineering team

Come work with our team wayve.ai/careers

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